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Factors influencing the choice of radiology as a medical specialty in Ireland

Turlough Lynch, Sophie Bockhold^{*}, Jonathan P. McNulty

School of Medicine, University College Dublin, Ireland

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ABSTRACT

Purpose: To gain further insight into Irish medical students' and interns' specialty preferences and explore the various factors that influence choice of specialty with a focus on radiology.

Methods: An online cross-sectional survey was conducted of medical students and interns enrolled at a single Irish institution. Survey topics included specialty preferences, associated influential factors, exposure to radiology to date, and respondents' interest in and understanding of radiology.

Results: Cardiology, emergency medicine, and paediatrics had the highest overall interest levels, with 27.0% (n = 133/492) of all participants declaring an interest in radiology. The most frequently selected reason for considering radiology as a specialty was the varied nature of the field. Men reported considering a career in radiology more often than women ($\chi^2(1, n = 433) = 9.464, p = 0.002$) and non-European respondents considered radiology less often than their Irish and European peers ($\chi^2(1, n = 436) = 7.510, p = 0.006$). While there was no significant association between exposure to radiology and interest in the specialty, participants with previous exposure to radiology were found to be more knowledgeable about the roles and responsibilities of a radiologist. **Conclusion:** The outcomes of this study support previous research which concludes that medical students' choice of specialty is multifactorial. A strategic approach needs to be taken towards undergraduate radiology education which accounts for class composition, emphasises the diversity and impact of the field, and provides clinical exposure to the subject matter, as a tailored means of steering more students and interns towards the underserved discipline.

1. Introduction

The field of radiology represents a critical pillar of the modern healthcare framework, providing a means by which to both diagnose and treat human disease across a multitude of medical disciplines. Despite its breadth and undeniable importance to patient management, radiology makes up a relatively small proportion of Ireland's healthcare workforce with an overall vacancy rate of 8% and one of the largest workforce shortages among registered medical specialties [1–3]. Furthermore, the rapid advancement of medical imaging technology and increasing number of novel clinical applications has resulted in an unremitting demand for radiology services that has been met with a continually increasing shortage of capable radiologists across the country [2]. Growing workforce shortages have also been reported for the United Kingdom (UK), France, and to a lesser extent Sweden, though Germany and Denmark have been shown to have a sustainable balance between demand and growth capacity indicating this issue is common

but not universal [4].

The Irish Health Service Executive (HSE) has estimated a 58% increase in radiology workforce is required by 2027 if the country is to meet the growing demands for both clinical radiology (medical imaging, nuclear medicine, and interventional radiology inclusive) and radiation oncology alike [2,3]. One approach to overcoming the undersupplied workforce is increasing the number of radiology trainees; but, to implement a successful expansion of the radiology training scheme, there must be sufficient medical students interested in pursuing such a career. A factor that may not be trivial given medical student's variable interest in radiology over the years [5]. It is crucial that we understand what is motivating the choice of medical specialty, in particular the factors influencing individuals towards and away from radiology as a profession and incorporate this knowledge into strategic agendas and workforce planning that safeguard the field of medical imaging.

Various studies have been conducted to explore the factors influencing students' choice of radiology as a medical specialty. The

Abbreviations: AI, Artificial Intelligence; ESR, European Society of Radiology; GEM, Graduate Entry Medicine; HSE, Health Executive Service; HST, Higher Specialty Training; IDT, Inter Deanery Transfer; UEM, Undergraduate Entry Medicine; UK, United Kingdom.

^{*} Corresponding author at: School of Medicine, Health Sciences Centre, University College Dublin, Belfield, Dublin 4, Ireland.

E-mail address: sophie.bockhold@ucd.ie (S. Bockhold).

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intellectual and technical components of the discipline, work environment, impact on patient care, overall lifestyle, and educational exposure represent some of the most frequently reported factors that draw individuals towards the specialty [5–7]. On the other hand, misconceptions about radiology, a deficient understanding of the medical imaging field, and trepidations surrounding artificial intelligence (AI) have been reported to negatively impact entrance rates to radiology specialty training [6,8,9]. Gender disparity among radiology applicants and within the medical imaging workforce have also been extensively documented [6,10]. Furthermore, review of the current literature demonstrates variable interest in radiology by region [11,12].

To date, much of the current knowledge around specialty selection arises from North American and United Kingdom cohorts and there has been little investigation into the factors influencing choice of radiology as a specialty in Ireland specifically. While the findings from previous studies provide valuable insights, the differing backgrounds and noted inconsistencies in medical school curricula, training schemes, and job markets warrants further investigation at the institutional and regional levels [4,5,13–17]. Therefore, the purpose of this study was to gain further insight into medical student's specialty preferences and associated influences via an online survey distributed to all registered medical students and medical interns at a single Irish institution. Specifically, this institution offers both a 6-year undergraduate entry medicine programme and an accelerated 4-year graduate entry medicine programme, following which students must complete 2–3 years clinical experience plus 5-years in the Faculty of Radiologists' Higher Specialist Training (HST) programme should they wish to specialise in either diagnostic radiology or radiation oncology [18]. Findings were compared with previous research to identify convergence and divergence of trends and the results examined for their potential benefit to undergraduate education and training.

2. Material and methods

A cross-sectional survey was conducted of undergraduate entry medical students, years one through six (UEM1-UEM6), and graduate entry medical students, years one through four (GEM1-GEM4), who were enrolled in the 2018 Autumn trimester at University College Dublin School of Medicine. The survey was also distributed to medical interns registered with the UCD Intern Network at the time of distribution. The survey was created and housed within the SurveyMonkey® secure online platform and distributed via the university targeted email communications system. Responses were collected from September 21 through October 23, 2018, and participation was both voluntary and anonymous. The survey contained 20 unique questions covering demographics, specialty preferences and associated influential factors, exposure to radiology to date, and respondents' interest in and understanding of radiology (see Supplemental Material for full survey). The study received an exemption from full institutional review board approval (Reference: LS-E-17-40- Lynch-McNulty) and permission to undertake the study was granted by the Head of School/Dean of Medicine.

Following the close of the survey, responses were analysed for trends to gain insight into current interest levels in radiology and the factors influencing student's motivation to pursue a career in this field. A combination of descriptive statistics and weighted averages were used to describe the study population, appraise student's understanding of radiology, gauge exposure to the specialty thus far, and rank the various influential factors. Responses were then analysed using SPSS statistical software version 27 (IBM SPSS Inc., Chicago, USA) to assess if interest in radiology and the factors influencing specialty choice were the same across the different years of study and various self-reported backgrounds and genders. Additionally, responses were compared between participants who had experience or educational programming related to radiology and those participants who had no previous experience or training in the subject area to explore the impact of exposure on

individuals' understanding of radiology and motivation to pursue a career in this specialty.

3. Results

3.1. Demographics

The survey was distributed to a total of 1,552 medical students and interns. From this population there were 492 complete and partially complete responses, corresponding to an overall response rate of 31.7%. 61.2% (n = 301/492) of participants were enrolled in the Undergraduate Entry Medicine (UEM) programme, 33.7% (n = 166/492) of respondents were Graduate Entry Medicine (GEM) students, and 5.1% (n = 25/492) were medical interns. The majority of respondents were of Irish background (n = 307/492; 62.4%), while 32.3% (n = 159/492) identified as non-European, and the remaining 5.3% (n = 26/492) declared themselves as having a European background. There was a large discrepancy between genders with 184 (37.4%) male respondents versus 305 (62.0%) female respondents, and three (0.6%) individuals identifying as neither male nor female. Of the 492 participants, the vast majority (n = 406/492; 82.5%) were 18 to 25 years of age, with an additional 12.8% (n = 63/492) falling within the 26 to 29 years of age bracket, and 4.7% (n = 23/492) 30 years of age or older. A full breakdown of demographics by year of study can be found in Table 1. Overall, this sample was representative of the 2018 student population which comprised 65.9% UEM and 34.1% GEM students, with 54.6% of students identifying as female versus 45.4% male, 64.7% Irish, 33.5% non-European, and 1.8% European. Where there was some discrepancy between the respondents and the overall student population was in the age profile of students, where 47.5% were 18 to 25 years old, 40.0% were 26 to 29 years old, and the remaining 12.4% were 30 years of age or older in the overall population.

3.2. Specialty preferences and associated influential factors

When asked to broadly declare their interest, 12.5% (n = 57/458) of question respondents noted an interest in surgery and 45.9% (n = 210/458) expressed interest in medical specialties, while the remaining 41.7% (n = 191/458) had interest in both surgery and medicine. Participants were then given a list of specialties currently recognised in Ireland and asked to rank their top ten preferences in order from highest (i.e. greatest interest in pursuing) to lowest (i.e. least interest in pursuing). Through analysis of the weighted average rankings, it was found that cardiology, emergency medicine, and paediatrics had the highest overall interest levels, with radiology ranking eleventh out of the fourteen listed options (Table 2). Investigation regarding the level of influence various factors have had on participant's specialty preference found "current exposure/knowledge of the field" had the strongest influence, followed by "extent of patient contact" and "working environment and relationships" (Table 2).

3.3. Factors influencing choice of radiology as a medical specialty

Of the 436 participants who answered the question 'are you considering radiology as a future specialty?' 30.5% (n = 133/436) responded 'yes'. Analysis by Chi-squared Test of Independence revealed both gender and background to be associated with respondent's declared interest level; men more likely to consider radiology as a specialty compared to women (χ^2 (1, n = 433) = 9.464, p = 0.002) and non-European participants considering radiology less frequently than their Irish and European counterparts (χ^2 (1, n = 436) = 7.510, p = 0.006). Programme type and year of study were also found to be associated with an interest in radiology. A sub-analysis by programme revealed that Graduate Entry Medical students were significantly more likely to consider radiology as a specialty than Undergraduate Entry Medical students (χ^2 (1, n = 413) = 4.487, p = 0.034). Further analysis by

Table 1
Summary of participant demographics by year of study.

Year of Study[n (% total respondents)]	Background[n (%)]			Gender(n (% of total respondents))			Age(n (% of total respondents))			
	Irish	European ²⁶	Non-European	Male	Female	Other	18–21 years	22–25 years	26–29 years	>30 years ²³
	307 (62.4%)	(5.3%)	159 (32.3%)	184 (37.4%)	305 (62.0%)	3 (0.6%)	183 (37.2%)	223 (45.3%)	63 (12.8%)	(4.7%)
UEM^a										
UEM1 [53 (10.8%)]	28 (52.8%)	1 (1.9%)	24 (45.3%)	23 (43.4%)	30 (56.6%)	–	49 (92.5%)	3 (5.7%)	1 (1.9%)	–
UEM2 [59 (12.0%)]	33 (55.9%)	1 (1.7%)	25 (42.4%)	17 (28.8%)	42 (71.2%)	–	58 (98.3%)	–	–	1 (1.7%)
UEM3 [61 (12.4%)]	26 (42.62%)	6 (9.8%)	29 (47.5%)	23 (37.7%)	38 (62.3%)	–	47 (77.1%)	13 (21.3%)	1 (1.6%)	–
UEM4 [49 (10.0%)]	34 (69.4%)	2 (4.1%)	13 (26.5%)	19 (38.8%)	30 (61.2%)	–	22 (44.9%)	26 (53.1%)	–	1 (2.0%)
UEM5 [43 (8.7%)]	33 (76.7%)	1 (2.33%)	9 (20.9%)	10 (23.3%)	33 (76.7%)	–	3 (7.0%)	39 (90.7%)	–	1 (2.3%)
UEM6 [36 (7.3%)]	23 (63.9%)	2 (5.56%)	11 (30.6%)	15 (41.7%)	21 (58.3%)	–	–	35 (97.2%)	1 (2.78%)	–
GEM^b										
GEM1 [44 (8.9%)]	29 (65.9%)	–	15 (34.1%)	17 (38.6%)	27 (61.4%)	–	4 (9.1%)	28 (63.6%)	9 (20.5%)	3 (6.8%)
GEM2 [49 (10.0%)]	31 (63.3%)	2 (4.1%)	16 (32.7%)	18 (36.7%)	31 (63.3%)	–	–	35 (71.4%)	10 (20.4%)	4 (8.2%)
GEM3 [41 (8.3%)]	29 (70.7%)	4 (9.8%)	8 (19.5%)	19 (46.3%)	20 (48.8%)	2 (4.9%)	–	16 (39.0%)	19 (46.3%)	6 (14.6%)
GEM4 [32 (6.5%)]	18 (56.3%)	5 (15.6%)	9 (28.1%)	14 (43.8%)	17 (53.1%)	1 (3.1%)	–	9 (28.1%)	17 (55.3%)	6 (18.8%)
Interns [25 (5.1%)]	23 (92%)	2 (8.0%)	–	9 (36.0%)	16 (64.0%)	–	–	19 (76%)	5 (20.0%)	1 (4.0%)

^a UEM = Undergraduate Entry Medicine.

^b GEM = Graduate Entry Medicine.

Table 2

Specialty preferences and associated influential factors by weighted average ranking (higher values correspond with higher ranking and thus greater preference for pursuing that specialty). Radiology and the top three influential factors are highlighted in bold.

Specialty	Weighted Average
Medicine (Cardiology)	9.68
Emergency Medicine	9.57
Paediatrics	9.39
General Practice	8.45
Medicine (Neurology)	8.42
Surgery	8.07
Medicine (Gastroenterology)	7.8
Medicine (Respiratory)	7.74
Obstetrics and Gynaecology	7.65
Anaesthesia	7.36
Radiology	5.82
Psychiatry	5.77
Pathology	4.72
Other	4.55
Factor	Weighted Average
Current exposure/knowledge of the field	3.33
Extent of patient contact	3.31
Working environment & relationships	3.18
Work/life balance	3.05
Diversity within the field	3.02
Interest in acute patient management	2.83
Mentor or role model influence	2.67
Academic examination results	2.54
Competition for training scheme	2.48
Income potential or future earnings	2.33
Length of training	2.29
Status of the specialty	1.94
Potential litigation and legal issues	1.87
Family expectations	1.7

comparative years of study across programmes (UEM 1–3/GEM 1 vs. UEM 4/GEM 2 vs. UEM 5–6/GEM 3–4/Interns) also showed that UEM 4/GEM 2 students were significantly more likely to consider radiology as a specialty than their UEM 1–3/GEM 1 counterparts ($\chi^2 (1, n = 278) = 4.830, p = 0.028$) and slightly more likely to consider a career in radiology than UEM 5–6/GEM 3–4 students and Interns, though the latter difference was not statistically significant.

The most frequently selected reasons for considering radiology as a specialty were, in descending order of frequency: the varied nature of the field; an interest in the specialty; and the appeal of radiology’s physics and technology component. For those who selected ‘Other’ as their reasoning, work-life balance was the most frequently reported motive. Conversely, the most common explanations for not considering a career in radiology were: participants found radiology interesting but did not want to do it all the time; their minds were set on pursuing another specialty; or they felt radiology has too little patient interaction. Additionally, within the open-ended section, multiple students shared that the basis for them not considering radiology was, at least in part, due to a lack of knowledge in the specialty and the potential for radiological applications of AI to shrink the current job market. The full ranked list of reasoning, both for and against considering radiology as a specialty, can be seen in Table 3. While the top reasons for considering radiology remained the same across all years of study (UEM 1–3/GEM 1 vs. UEM 4/GEM 2 vs. UEM 5–6/GEM 3–4/Interns), “too little patient interaction” became an increasingly important reason for not considering radiology as students approached the end of their medical degree ($\chi^2 (1, n = 300) = 18.116, p < 0.001$). Similarly, a comparison of this reasoning across gender via Chi-Square Test of Independence revealed that the physics and technology component of radiology was more appealing to men than women ($\chi^2 (1, n = 132) = 13.209, p < 0.001$). Interestingly, analysis also revealed that non-European students were significantly more likely to have their mind made up to pursue another specialty compared to their Irish contemporaries ($\chi^2 (1, n = 285) = 34.209, p < 0.001$). This trend could also be seen across European and

Table 3
Reasons for and against considering radiology by frequency of responses.

Reason for considering Radiology	Response [% (n)]	
	Yes	No
Radiology is very varied	82.7% (110)	17.3% (23)
Very interested in the specialty	61.7% (82)	38.4% (51)
Physics/technology component is appealing	46.6% (62)	53.4% (71)
I know somebody working in radiology	27.1% (36)	72.9% (97)
Radiology training is competitive	21.8% (29)	78.2% (104)
Lots of patient interaction	17.3% (23)	82.7% (110)
Minimal patient interaction	13.5% (18)	86.5% (115)
Risk of radiation exposure	5.3% (7)	94.7% (126)

Reason for NOT considering Radiology	Response [% (n)]	
	Yes	No
Interesting but do not want to do all the time	70.3% (211)	29.67% (89)
My mind is made up to pursue another specialty	60.7% (182)	39.33% (118)
There is too little patient interaction	59.3% (178)	40.67% (122)
Physics/technology component not appealing	56.7% (170)	43.33% (130)
Radiology would not be varied enough	45.3% (136)	54.67% (164)
Risk of radiation exposure	23.8% (71)	76.25% (228)
I know somebody working in radiology	8.0% (24)	92.00% (276)
Radiology training is too competitive	7.0% (21)	92.98% (278)
There is too much patient interaction	0.7% (2)	99.33% (296)

non-European students; however, the difference in selected frequency was not found to be statistically significant.

3.4. Exposure to radiology

When students and interns were asked about their exposure to radiology thus far, 268 individuals, corresponding to 60.0% of the 447 question respondents, stated they had some exposure to date. When filtered solely for final year student's responses (UEM Year 6 and GEM Year 4) this value increased to 100% (n = 64/64), although 70.6% (n = 125/177) of upper year students (i.e., UEM Years 5 and 6 and GEM Years 3 and 4) claimed there was too little exposure to radiology throughout their medical degree. Incidentally, 20.8% (n = 5/24) of the 24 interns who responded stated they had no exposure to radiology to date. When broken down by type of exposure, a Year 1 (UEM) module, *Healthcare Imaging and Information Systems*, was the most frequently cited means of exposure (56.3%; n = 138/245), followed by previous personal (45.5%; n = 110/242), and clinical (40.0%; n = 98/245) experiences related to radiology (Table 4). The majority of respondents stated they chose to take part in a radiology related course or experience, not because they were considering radiology as a specialty choice, but because they required an understanding of radiology for another specialty of interest. When asked if their experiences turned them toward or away from

Table 4
Type of exposure to radiology by frequency of response.

Current Exposure to Radiology	Response [%(n)]	
	Yes	No
Stage 1 Healthcare Imaging & Information Systems module	56.3% (138)	43.7% (107)
Radiology & Diagnostic Imaging option module	32.1% (79)	67.9% (167)
Other core module(s)	26.8% (64)	73.2% (175)
Other elective module(s)	12.2% (29)	87.8% (209)
Previous qualification	4.7% (11)	95.3% (223)
Previous clinical experience related to radiology	40.0% (98)	60.0% (147)
Previous personal experience related radiology	45.5% (110)	54.6% (132)
Other (please specify)	9.6% (25)	

radiology, 29.0% (n = 76/262) responded toward, while 20.6% (n = 54/262) responded away and the remaining 132 of the 262 respondents claimed their experience did not influence them in either direction. Analysis by Chi-Square Test of Independence aligned with these response rates, indicating no significant association between previous exposure to radiology and an interest in radiology as a specialty ($\chi^2(1, n = 436) = 1.667, p = 0.197$).

3.5. Understanding of radiology

To gain insight into medical students' and interns' understanding of the specialty, participants were asked a series of questions regarding the roles and responsibilities of a radiologist. A summary of their responses can be found in Table 5. Not surprisingly, individuals with previous exposure to radiology were found to be more knowledgeable about the specialty than their non-exposed peers and had a better understanding that radiologists diagnose disease ($\chi^2(1, n = 436) = 8.485; p = 0.004$), perform medical procedures ($\chi^2(1, n = 436) = 13.105; p < 0.001$), perform surgical procedures ($\chi^2(1, n = 436) = 16.615; p < 0.001$), and are not involved in performing conventional X-rays/radiographic examinations ($\chi^2(1, n = 436) = 5.696; p = 0.017$). Exposure to radiology also corresponded to an increased agreement with the statement "Radiologists play an important role in diagnosis and patient management" ($\chi^2(1, n = 436) = 4.451; p = 0.035$) and a much better understanding of the difference between a radiologist and a radiographer ($\chi^2(1, n = 436) = 190.856; p < 0.001$).

4. Discussion

4.1. Factors influencing specialty choice

Overall, the top self-selected factors influencing student's choice of medical specialty were "current exposure/knowledge of the field," "extent of patient contact," "working environment and relationships," and "work-life balance." When looking at reasons for considering radiology specifically, the diversity of the field, and interest in the subject were most frequently cited. These factors are relatively well aligned with what is reported in the literature; however, the impact of each factor was found to be somewhat unique with the current respondents placing

Table 5
Understanding of radiologist's roles and responsibilities displayed as frequency of responses.

Radiologist Roles and Responsibilities	Exposure to Radiology [%(n)]		No Exposure to Radiology [%(n)]	
	Yes	No	Yes	No
Diagnose patients	86.3% (226)	13.7% (36)	75.3% (131)	24.7% (43)
Direct radiographers to optimise/set the parameters used for differing image modalities	81.7% (214)	18.3% (48)	85.6% (149)	14.4% (25)
Have responsibility for the practical radiation protection of patients undergoing X-ray or CT examination	79.0% (207)	21.0% (55)	75.9% (132)	24.1% (42)
Direct medical treatment	71.8% (188)	28.2% (74)	64.9% (113)	35.1% (61)
Direct surgical treatment	70.6% (185)	29.4% (77)	63.8% (111)	36.2% (63)
Perform medical procedures	63.0% (165)	37.0% (97)	45.4% (79)	54.6% (95)
Meet with patients	62.2% (163)	37.8% (99)	63.8% (111)	36.2% (63)
Perform surgical procedures	50.8% (133)	49.2% (129)	31.0% (54)	69.0% (120)
Perform conventional X-rays/radiographic examinations (e.g., chest and musculoskeletal X-ray)	45.8% (120)	54.2% (142)	57.5% (100)	42.5% (74)

much less emphasis on work-life balance than previous cross-sections of the global medical school population [11,12]. A systematic review conducted by Levaillant et al. in 2020 identified work-life balance as the most influential factor to student's choice of specialty, followed by interest in the subject, academic background (including influence of role models), and diversity of the discipline [11]. A similar review by Yang et al. in 2019 found that academic interests, controllable lifestyle, patient service orientation, and medical educators have the largest influence on subspecialty selection, with competency in the field becoming a strong motivator over the past decade [12]. The systematic reviews also highlight a notable variability by region [11,12]; the current study adhering to the general archetype of higher income countries described by Levaillant et al. and Yang et al. Surprisingly, seven respondents to the current survey had cited the "risk of radiation exposure" as a reason for considering radiology as a specialty; perhaps the intrigue of radiation protection, particularly given the emphasis placed on this subject following implementation of the most recent *Basic Safety Standards Directive* [19], was a contributing factor underpinning this seemingly counterintuitive response.

Interestingly, the present results also demonstrate a clear trend that non-European students are less likely to pursue a career in radiology compared to their Irish and European counterparts and put greater emphasis on current exposure and knowledge of the field when considering specialties. A look at the proportion of trainees who selected radiology upon completion of their undergraduate medical degree shows only 3.2% of American residency applicants [20] and 3.5% of Canadian residency applicants [21] selected diagnostic radiology or radiation oncology as their preferred specialty choice. In comparison, 6.6% of individuals within the Higher Specialty Training (HST) programme in Ireland were undergoing training in these sub-specialties [22], and 3.5% of United Kingdom Round 1 specialty recruitment, plus 7.5% of applicants to the UK's National Inter Deanery Transfer (IDT) process were in clinical radiology [23,24]. This data not only corroborates the presence of regional differences, even among occidental nations, but also sheds light on the need for impactful exposure to medical imaging if international students are to be targeted as radiologist candidates. A strategy that could prove to be essential if Ireland is to bring on board the 150 additional radiologists required to meet the European national average of 8 radiologists per 100,000 by 2027 [3]. The required up-scale in radiology workforce is even more exacerbated in the United Kingdom where the shortfall of clinical radiologist consultants is projected to reach 3,600 by 2025 [25].

The current survey is also consistent with the robust body of literature reporting a disproportionate number of men interested in radiology compared to women. An intrinsic trend that is reflected in Ireland's clinical radiology workforce where there exist 2.2 male specialists to every one female [2]. An analysis by gender revealed this disparity may be in part due to men's increased interest in the physics and technology component. Conversely, an extrinsic factor that has been widely documented throughout the literature is student's level of exposure to radiological subject matter, with reports of too little and highly variable radiology content across undergraduate programmes [6–8,13,17,26,27]. While "exposure/knowledge of the field" ranked highest out of the self-selected factors influencing respondents' choice of medical specialty at large (radiology or otherwise), sub-analysis of respondents who had versus those who had not been exposed to radiology throughout their education revealed no association between previous exposure to the specialty and a declared interest in radiology specifically. The latter findings are a divergence from previous research conducted by Arleo et al. in 2016 [6] and Branstetter et al. in 2007 [27] which demonstrated an association between respondents' exposure to radiology and an interest in the specialty, although Arleo et al.'s findings were not statistically significant and the current findings converge with respect to previous experiences neither steering students towards nor away from radiology in most instances [6]. Additionally, the current study demonstrates exposure to medical imaging has a significant

impact on students' knowledge and positive perception of radiology, which coincides with previous findings [6,27]. It should also be noted that sub-analysis of comparative years of study across programmes demonstrated a peaked interest in radiology at the end of student's pre-clinical years with UEM 4/GEM 2 students significantly more likely to consider radiology as a specialty than their UEM 1–3/GEM 1 counterparts. An interest that appears to wane during student's clinical years of study. This trend could potentially be due to student's pre-clinical exposure to radiological content sparking an interest in the specialty; students' interest subsequently overshadowed by the allure of other specialties encountered during clinical rotations with radiology currently omitted from the list of scheduled clerkships. A 2019 study out of the United States found clerkships to be the most influential factor in steering medical students towards their specialty choice, a finding that further supports the proposed theory [7]. When looked at in the context of increasing the radiology workforce, these outcomes indicate the quantity of radiology education, although important, should come second to developing a nuanced and impactful approach to radiology education that incorporates clinical experience and makes the field more attractive to the next generation of practitioners.

4.2. Recommendations based on survey findings

With both intrinsic and extrinsic factors clearly at play, the question now becomes, how is this knowledge best exploited to attract medical students towards a career in radiology and ensure the stability and success of this critically important specialty? A few recommendations are put forth for consideration which leverage the current infrastructure and resources for undergraduate radiological education and training. Firstly, vertical integration of radiological content should be consistently incorporated across all stages of the medical school curriculum [28] via a combination of dedicated radiology modules (or lectures) and integration with other core subjects such as anatomy, pathology, and systems biology. In this way, students are exposed to radiology in a manner that showcases the specialty's clinical relevance, diversity, and interdisciplinary nature via a nuanced approach for increased receptivity and fewer misconceptions. A 2010 survey conducted by the European Society of Radiology (ESR) revealed that most institutions across Europe do not cover radiology at all within the pre-clinical curricula despite the well-documented value of exploiting medical imaging at an early phase [13,29–34]. While the current survey presents some conflicting results around early exposure's impact on interest levels, perhaps due to the small sample size, there is a clear association between exposure and knowledge of the field which was reported as a top influential factor on specialty preference. Thus, University College Dublin's incorporation of a required Year 1 (UEM) module, *Healthcare Imaging and Information Systems*, is a potential contributor to the high interest level in radiology reported for the current study cohort. The lack of mandatory/core module in radiology in the GEM programme perhaps why five respondents noted no exposure to radiology to date. Despite the lack of such a core module, radiology content is embedded across other modules, but the absence of an independent 'Radiology' module may hinder the development of greater interest in the specialty as identified in previous studies [6,27]. Aligned with this recommendation, the ESR curriculum and overarching strategic framework for undergraduate education provides a valuable foundation upon which to standardise and improve undergraduate radiology curricula at large [35].

Secondly, it is important that the expertise of experienced radiologists be leveraged for not only the instruction of radiological content, but the development and review of medical school curricula to ensure a harmonised and strategic integration of the most relevant radiology subject matter. This allows radiology to be taught in a robust and progressive manner that is optimally integrated with the curriculum at large, while minimising redundancies and gaps in essential knowledge within what is already an often overloaded timetable [13,29,36]. The ESR's 2015 guide to 'Teaching Undergraduates Radiology' along with

the recently published ‘Tips for Educators’ offer additional resources to help radiologists/instructors have their students better engage with radiology subject matter [37,38]. Finally, it is proposed that medical schools implement a mandatory clinical rotation in radiology. While radiology clerkships are common throughout Europe and North America, they are obligatory in <50% and 20% of European and North American institutions respectively [5,29] despite the well-established value of such clerkships for high quality patient care in subsequent clinical practice, regardless of chosen specialty, and clinical exposure’s association with increased interest levels in radiology among medical students [6,7,29]. However, it is important that these mandatory rotations not be focused solely on the reading room experience; rather, it is essential that clinical exposure emphasises the specialty’s highly clinical nature, direct involvement in patient care, multidisciplinary aspects, and numerous opportunities for subspecialisation and inter-disciplinary collaboration [29]. In this way, the proven benefits of clinical exposure can be exploited with regard for factors influencing specialty choice, and senior students’ interest in radiology better maintained, or even increased.

5. Conclusion

There are several limitations to our study, most notably the small and imbalanced sample size from a single institution, self-selection sampling, response bias, and the temporal confines imposed by the cross-sectional design which have been compounded by the interval to publication. Nonetheless, the results provide valuable insight into the factors that influence Irish medical students’ choice of specialty and their current perceptions and knowledge of radiology. When assessed alongside the literature, these outcomes confirm that selection of a medical specialty is multifactorial, with both intrinsic and extrinsic components. Furthermore, it is becoming increasingly apparent that the factors influencing specialty selection are variable by region [11,12]. Thus, it is recommended that a strategic approach be taken towards radiology training which accounts for variable class composition, emphasises the diversity of the field and impact on patient care, and provides clinical exposure to the subject matter as a tailored means of steering more students towards the underserved discipline. Additionally, further investigation is needed into the role AI plays in medical students’ preference for radiology as their future specialty and to identify the education and training needs for improved understanding around the benefits of AI for radiological practice [9]. The importance of evidence-based radiology and involvement in radiology research as a means of improving student perceptions should also be considered and presents another area for future research [39,40]. Lastly, additional multi-centre studies are needed to expand on the present findings for a fully informed view of progression into radiology training schemes in Ireland and across Europe.

Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical approval

Exemption from full Institutional Review Board approval was obtained. Human Research Ethics Committee – Sciences Research Ethics Exemption Reference Number (REERN): LS-E-17-40-Lynch-McNulty.

Informed consent and patient information

Written informed consent was not required based on Institutional Review Board guidance.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ejrad.2022.110297>.

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